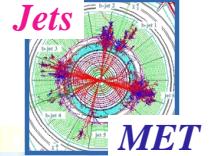




# HCAL CODE IN ORCA



Salavat Abdullin, UMD



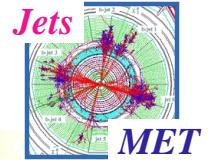
- **Proposed prototype (CMS IN-2001/037)**
  
- **Some tests**
  - CaloRecHit thresholds impact  
on jet / dijet resolution
  - use of HO in muon trigger
  
- **Plans**

- Realistic noise
  - Noise sigma per time bucket : 2 pe
- HPD photo statistics effect
  - sizeable for resolution at high energies
- QIE integration in 25 ns time buckets
  - ~ 91 % of the signal collected in 2 time buckets
- ACD quantization
  - Minimal ADC count = 3 pe ~ LSB of 330 (125) MeV in HB (HO)
- HF splitting from HB/HE
  - and from ECAL !
  - its own noise ~ 0.125 pe and ADC count ~ 0.43 pe
  - 1 bkt signal integration
- Layer 0 and 1 "optical" merging both in HB and HE





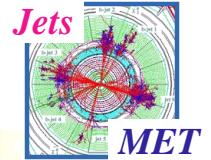
# CALO PACKAGES INVOLVED



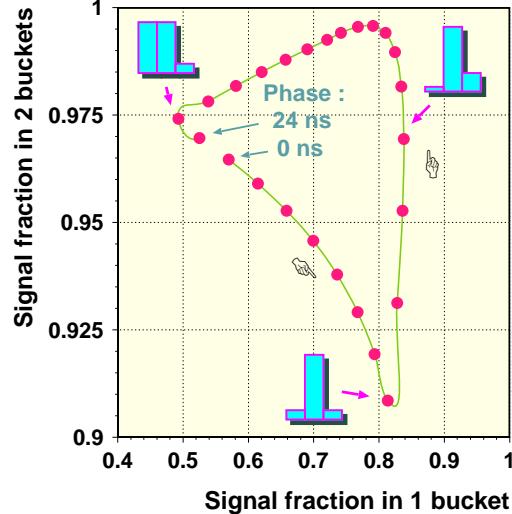
- **HcalRealistic** HF splitted from HB/HE, noise generation, ADC quantization
- **HcalRealisticRec** signal evaluation (off-line)
- **HcalTrigPrim** signal evaluation (L1 trigger)
- **HcalBarrel** layer 0 and 1 merging with weighting ("optical")
- **EcalPlusHcalTower** cuts and weights applied on constituents (CaloRecHit)
  
- **CaloHit** minor change to enable GEANT hits re-weighting
- **CaloTrigRec** minor change to split HCAL trigger reconstruction from ECAL one (!)
- **CaloReadout** HCAL ReadOut treatment is separated from ECAL one (so different !)  
some optional changes ( e.g. map -> static vector of CaloTimeSample)
- **CaloRecHit** some optional changes not related directly to HCAL  
(making available an info associated with RecHit)
- **CaloDetector** some optional changes not related directly to HCAL  
(e.g. assigning a unique ordinal number to all calo cells for direct ref.)



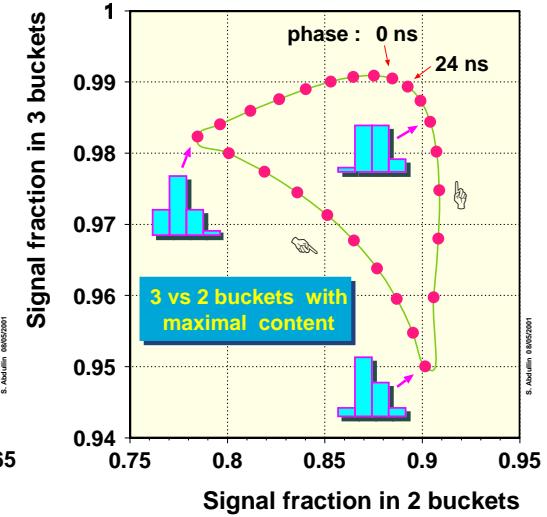
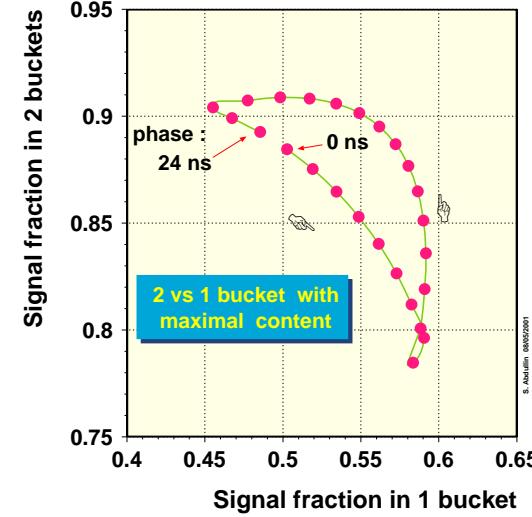
# HCAL SIGNAL SHAPE



**short**



**long**



**short**

**long**

★ Scintillator + wave-length shifter

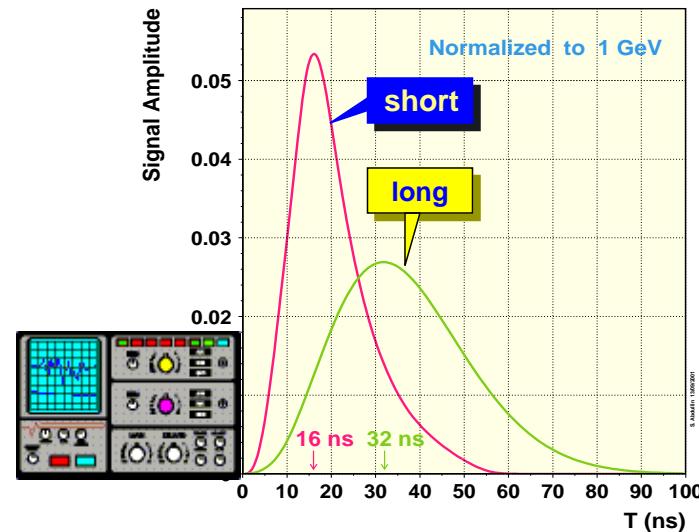
$$f_d(t) = \exp(-t/\tau_s), \quad \tau_s = 10 \text{ ns}$$

★ HPD

$$f_{HPD}(t) = 1.0 + (t/\tau_{HPD}), \quad \tau_{HPD} = 12 \text{ ns}$$

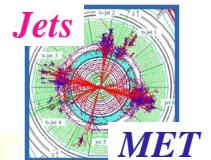
★ Preamplifier

$$f_p(t) = t * \exp(-t/\tau_p), \quad \tau_p = 5 \text{ ns}$$

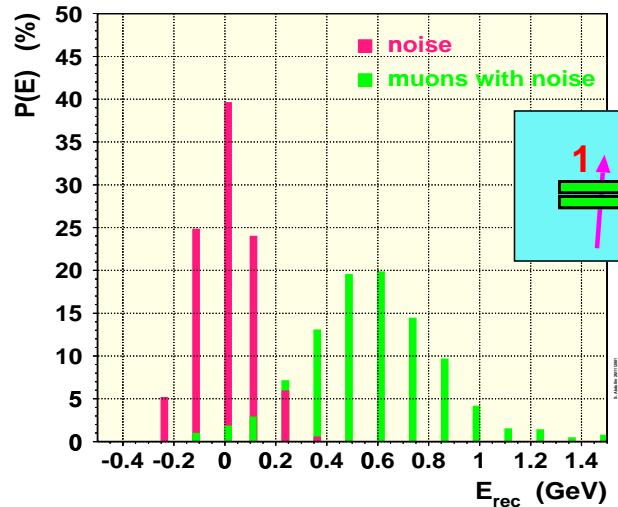


conservatively "long" signal is currently used ...

# EXAMPLE 1 : MUONS IN HO

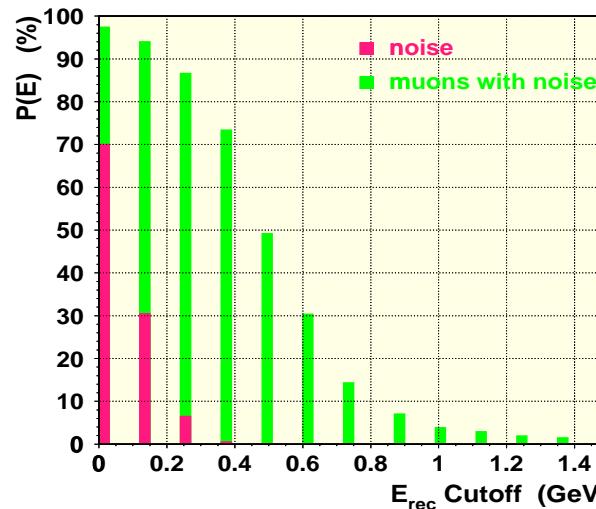
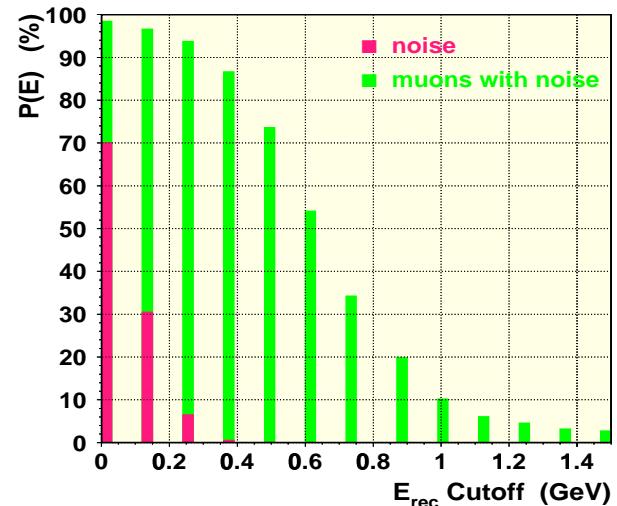
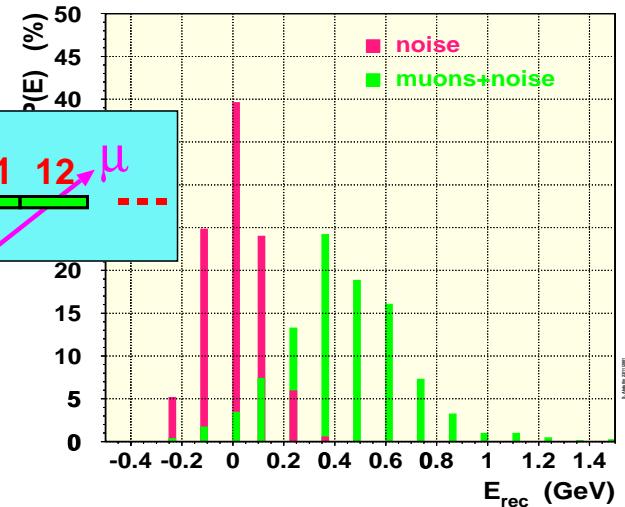


**HO central ring (1st tower) :  
two scintillator layers**



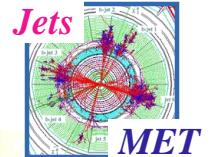
**Muon signal :~ 8 pe / scint.  
→ 0.25 MeV / pe  
(normal incidence)**

**HO third ring (12th tower) :  
one scintillator layer**





# EXAMPLE 2 : JET RESOLUTION VS THRESHOLDS



## ■ Readout thresholds (CaloRecHits)

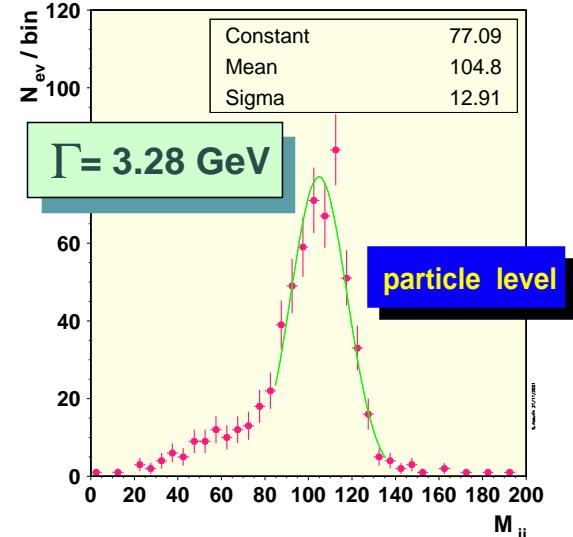
Set No	HCAL threshold (MeV)	ECAL threshold (MeV) barrel / forward	
1	- $\infty$	- $\infty$	- $\infty$
2	0	0	0
3	500	- $\infty$	- $\infty$
4	500	0	0
5	500	30*	150*
6	500	60**	300**

\*  $\sim 1\sigma_{\text{noise}}$

\*\*  $\sim 2\sigma_{\text{noise}}$

- ISR / FSR multiple interaction } on

- Particle-level preselection ( CMSJET ) : min. 2 jets with  $E_T > 30 \text{ GeV}$  within  $|\eta| < 2.5$



## ■ IterativeConeAlgorithm : corrected !

- R = 0.5
- Seed = 3 GeV
- $E_T^{\min} = 10 \text{ GeV}$

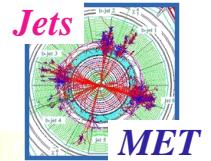


## ■ Jet energy corrections = f ( $E_T, \eta$ )

- for each ECAL+HCAL set of cuts
- quadratic fit in 12  $\eta$  bins (0-2.4)
- a bit special : fairly low jet energies
- R = 0.2 match,  $E_T^{\text{genjet}} > 30 \text{ GeV}$

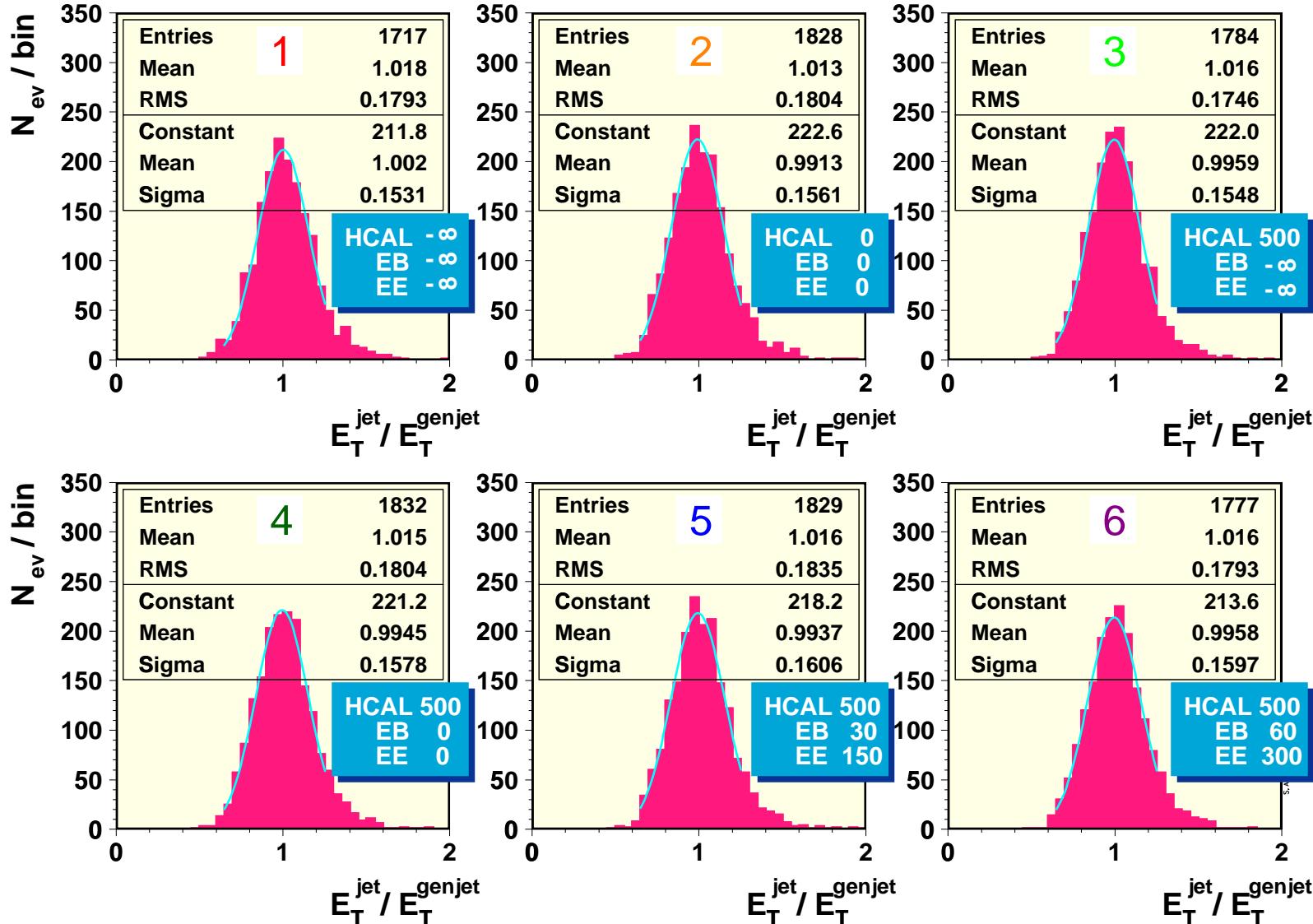


# EXAMPLE 2 : CONTINUATION



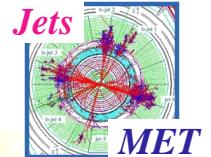
$E_T^{\text{genjet}}$  > 20 GeV

$E_T^{\text{jet}}$  > 20 GeV





# PLANS : ORCA AND TESTBEAM



- Layers (in addition to CMSIM compartments) treatment option (?)
- Light yield variation against tower
- Scale factors separately for GHEISHA and FLUKA
- Light collection time variation to implement
- ...
- Re-shuffle the HCAL (& calo) code entirely (?)
- Start prototyping **HcalTestBeam**
  - main preoccupation -  
DB of individual channel constants
  - manpower ...

